

BROTULID FISHES*

FROM THE ARCTURUS OCEANOGRAPHIC EXPEDITION

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(Figs. 29-33 incl. and Plate C.)

INTRODUCTION

Of the family Brotulidae, 80 specimens, representing 6 genera and 7 species, were taken by trawl, otter trawl and dredge in the following order:

AT STATION 26	Lat. 5° 03' N.	Long. 81° 08' W.	
	<i>Cherublemma</i>	<i>lelepris</i> gen. nov.	1 specimen
At STATION 74	Lat. 4° 50' N.	Long. 87° W.	
	<i>Lamprogrammus</i>	<i>illustris</i>	2 specimens
	<i>Mixonus</i>	<i>caudalis</i>	1 "
	<i>Porogadus</i>	<i>breviceps</i>	5 "
	<i>Dicrolene</i>	<i>nigra</i>	33 "
	<i>Dicrolene</i>	<i>gregoryi</i> , sp. nov.	1 "
	<i>Monomitopus</i>	<i>torvus</i>	35 "
AT STATION 84	Lat. 0° 17' S.	Long. 91° 34' W.	
	<i>Monomitopus</i>	<i>torvus</i>	3 specimens (young)
AT STATION 86	Lat. 0° 42' S.	Long. 91° 47' W.	
	Undetermined Brotulid		1 specimen (very young)
At STATION 87	Lat. 0° 00'	Long. 91° 53' W.	
	<i>Monomitopus</i>	<i>torvus</i>	1 specimen (young)

All of the brotulids of the Arcturus Expedition were taken from four stations in the Pacific Ocean between Panama and the Galapagos Archipelago. The majority, including all of the adult specimens, were taken at Station 74, the biggest station, in every sense of the word, made by the *Arcturus* during her whole six months voyage.

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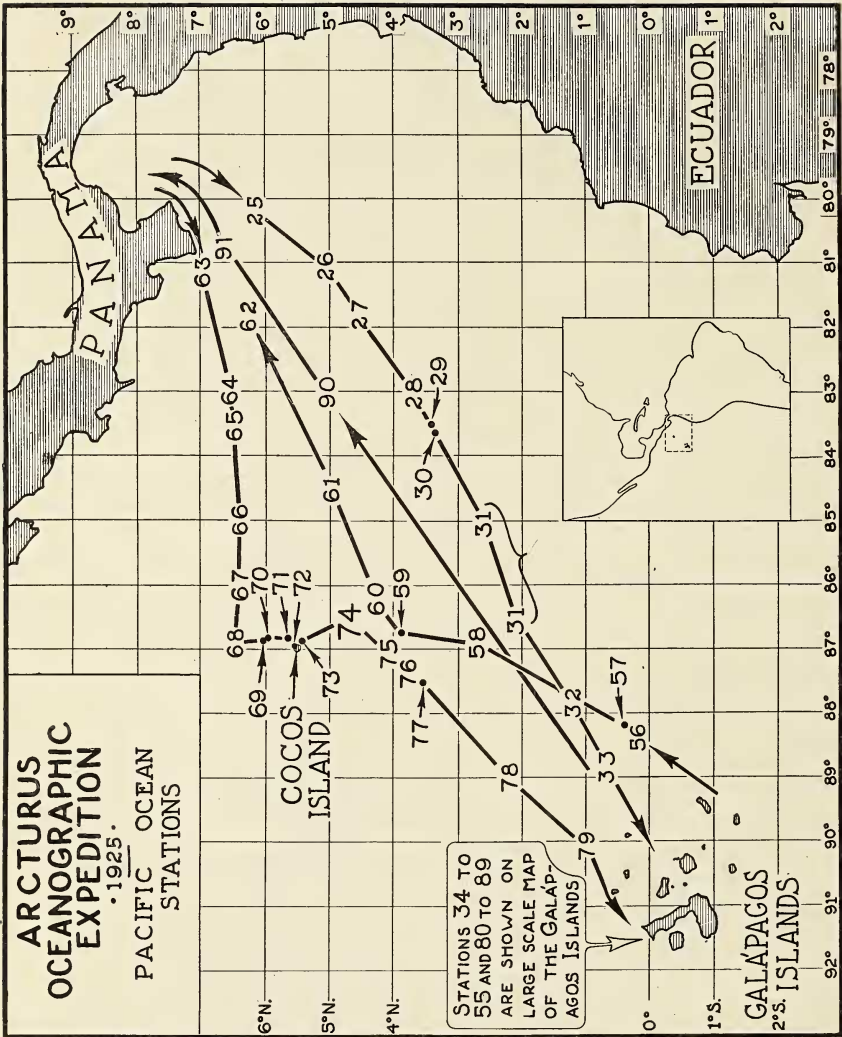


Plate C. Galapagos Islands' Stations. Arcturus Oceanographic Expedition.
From a drawing by John Tee-Van.

Station 74 endured for ten days while the *Arcturus* drifted within the immediate vicinity of Lat. 4° 50' N. and Long. 87° W. It was a station most lavish in material, especially fishes and crustaceans, which triumphantly corroborated Mr. Beebe's belief that the ocean may be investigated by the acre as well as by the degrees of the meridian. And it may be added that Station 74 was our dampest above water, for it was but sixty miles south of Cocos and consequently still within reach of the clouds gathered by that luxuriant and moist island.

Until Station 74 we had taken but few fishes from the deep sea that were not, in their diminutive frailness, incongruous when compared to the size and coarseness of the nets that had caught them, and we had grown used to preparing for the return of the immersed trawls with an array of glass jars and bowls and small aquaria. Very shortly, however, after Station 74 was made on May 25, 1925, we began to receive intimations that tubs and buckets and large aquaria had best be got ready.

On May 27th, the first brotulid, *Lamprogrammus illustris*, came up in T₁₉ from a depth of 450 fathoms, and it was still, though feebly, living.¹

On May 28, the first macrurid was taken in OT₁ from a depth of 900 fathoms.

On May 29, the otter-trawl, OT₂ from a depth of 750 fathoms brought up a load of small fishes, a few bathybial forms but mostly the delicate *Cyclothone*, *Argyropelecus*, and species plentiful in the shallower depths. While on the same day another otter-trawl, OT₃, from 833 fathoms, contained practically none but abyssal forms, including three brotulids and six macrurids.

On May 30, the otter-trawl, OT₄ brought up the largest deep sea haul of the trip for, without considering the meagre scattering of Silver Zone fishes that were caught in the mouth of the net on its way up, or the numbers of other abyssal forms, OT₄ from a depth of 625 fathoms contained 71 brotulids and three macrurids. Another net on the same day, OT₅ from an equal depth contained but one brotulid and only seven or eight other fishes, so enormously dependent on "luck" is fishing at such very long range.

On May 31, a dredge, D₁ from 844 fathoms added to our collection of big fish—some of them well over a foot in length—by one more brotulid and two more macrurids.

¹ Cf. "The Arcturus Adventure," by William Beebe, p. 362; fig. 54.

And on June 3, the last brotulid from Station 74 came up in another dredge, D₃ from 765 fathoms.

I have chosen to mention the numbers of macrurids that were caught along with the brotulids because these two families are so significantly alike in their general appearance and also in what is known of their habits and distribution. Their representatives taken by the 'Arcturus' certainly exhibit a conspicuous similarity of modification, enough to indicate that they enjoy at least the same kind of life. It seems reasonable to mention briefly some of these similarities because it is still a disputed question whether the brotulids are, phylogenetically, close to the macrurids or not.

These two families are similar in having soft, flabby bodies that dwindle to the most minute of caudals, although there is nothing in the least eel-like about their general expression.

Their heads are pitted with muciparous channels, although these are more conspicuous on the brotulids.

Their ventrals have undergone much reduction and must be used as tactile organs, if indeed they have not dwindled beyond any usefulness; and it is these ventrals, and in some genera filamentous pectorals, that are an indication of the bottom dwelling habits of these fishes. Their teeth are villiform, so fine (in most cases) that the French word for the character of their teeth, *en velours*, is most descriptive.

It is believed that these two families of fish are carnivorous, but not predatory, animals. To a superficial eye, however, it seems as though their ways of getting their food must be different, for in the case of the macrurids, the rosettes of spines on the tips of the elongated rostrums seem admirable instruments for stirring up the bottom mud together with the small creatures in it. The brotulids on the contrary have blunt snouts and their mouths are larger and better suited to engulf a bathybial, free swimming shrimp than to grub along the bottom.

With the exception of the specialized genus *Lamprogrammus*, all of the *Arcturus* macrurids and brotulids have the eyes peculiarly modified. Their eyes are covered with a heavy, rather opaque membrane that is continuous with the dark skin of the head, a very tough membrane with the eye set well behind it, its iris appearing like a soft blue ring.

Whenever macrurids and brotulids arrived upon the deck of the *Arcturus* they displayed the same symptoms of distress; most of

them had their heads thrown back, their branchiostegals spread like straining wings, and their mouths gaping; while a few individuals seemed quite untroubled by the swift change of pressure—except that they were dead.

These characters do not necessarily imply that there is a phylogenetic relationship between the families, for they are readily explained by the equalizing effect of an extremely uniform and exacting environment upon fishes that originally may have been highly dissimilar. But in view of these structural similarities it may be found that the habits of the little known Brotulidae are to the same extent similar to those of the better known Macruridae.

The macrurids are the best known of all the deep sea fishes, for although the brotulids have also been found in all the oceans, the latter have not even been given a secure classificatory niche, since it is still an open question whether they belong to the Acanthopterygii or the Anacanthini. Günther in 1873² included the brotulids in the Ophidiidae, while Brauer³ placed them in the Zoarcidae. Then Goode and Bean⁴ in 1895 raised them to family rank:—Brotulidae, under the super-family, Ophidoidea. And it was regarded as an accepted fact that the Brotulidae, closely associated with the Ophidiidae and the Zoarcidae, should come under the suborder Jugulares of the Acanthopterygii, and that they were to be looked upon as “degraded blennies,”^{5 6} their resemblance to the Macruridae being entirely superficial. In 1899, however, Garman,⁷ apropos of the lateral line systems of deep sea fishes, said: “The peculiar disks in the canals, hardly to be detected in those (species) of the shoals, attain a much greater development in the bathybial species and, in position and arrangement clearly indicating genetic relationship through common ancestry, are similar in families that in our systematic arrangements are widely separated.”

On the basis of his study and comparison of the lateral line systems, Garman removed the families Zoarcidae, Ophidiidae and Brotulidae from the Acanthopterygii and placed them with the Gadidae and Macruridae under the Order Anacanthini.

² “Deep Sea Fishes,” by A. Günther. Report of the Scientific Results of the Exploring Voyage of H. M. S. Challenger, 1873–76. Vol. XXII.

³ “Die Tiefseefische,” by A. Brauer. In Chun, *Wiss. Ergebnisse Deutsch. Tiefsee-Exped. “Valdivia,” 1898–99.*

⁴ “Oceanic Ichthyology,” by Goode and Bean. Smithsonian Institute, U. S. Nat. Mus.

⁵ “Fishes,” by David Starr Jordan, p. 733.

⁶ “Fishes” (Systematic Account of Teleostei), by G. A. Boulenger. In *Camb. Nat. Hist., 1904, vol. VII.*

⁷ Fishes of the “Albatross” Expedition, by S. Garman. *Mem. Mus. Comp. Zool., vol. 24.*

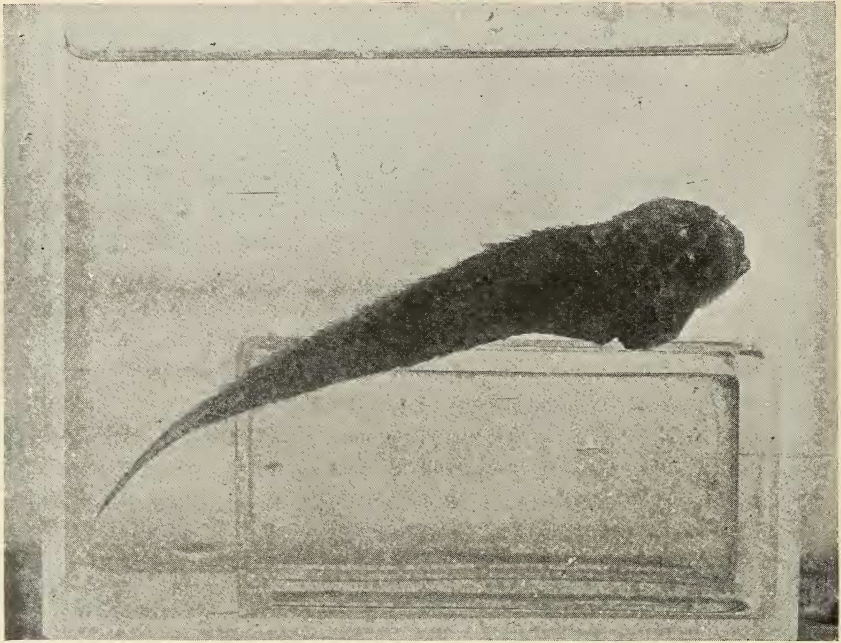


Fig. 29. *Lamprogrammus illustris* Garman. This specimen (A.M.N.H. 8451) came, still living in a net from the depth of 450 fathoms.

This arrangement of the families is further indicated to be the correct one by Cockerell⁸ who finds that the scales of the Brotulidae resemble these of the Ophidiidae and certain genera of the Gadidae.

The brotulids described and studied by Garman from the *Albatross* collection in 1899 were taken from much the same region of the Pacific as these brotulids taken by the Arcturus Expedition in 1925; and so this discussion is largely based upon Garman's descriptions.

For all of the color notes made upon fresh specimens, Ridgeway's color key book was used.

Lamprogrammus illustris Garman.

Mem. of the Mus. of Comp. Zoology XXIV, 1899, p. 174, Pl. XXXIV.

Station 74, in T₁, from 450 fathoms one specimen (Field no. 5948) A.M.N.H. 8451; and in OT₄, from 625 fathoms one specimen (Field no. 6037) A.M.N.H. 8452.

⁸ "The Scales of the Brotulid Fishes," by T. D. A. Cockerell. *Annals and Magazine of Natural History*, Oct. 1916. 8th ser., vol. xviii.

Of these the first, no. 5948 (8451) is probably not fully grown. It measures in length from snout to base of caudal, 126 mm.; in width across pectoral fin bases, 8.5; depth, between nape and humeral symphysis, 18.5; eye diameter, 3.2. It agrees well with Garman's description save in the matter of color. Garman gives no color notes, implying only that the fish is black. Our specimen, however, is a rich seal brown on head, belly and inside its mouth and branchial chambers; the same dark brown color continuing along its lateral line, while its muscular tracts are of a lighter brown.

The second specimen, no. 6037 (8452), is an adult female with partly developed eggs. It measures in length from snout to base of caudal, 260 mm.; width across the pectoral fin bases, 19 mm.; depth between nape and humeral symphysis, 44 mm.; eye diameter, 5 mm. It agrees well with Garman's description, differing only in that its head is slightly longer than deep and its eye slightly smaller than $\frac{1}{2}$ the snout. It differs in body proportions from the smaller specimen no. 5948 (8451) but not greatly enough to indicate any specific difference. In color, however, this specimen 6037 (8452) is a deep blue on head, body cavity and inside its mouth and branchial chambers, the same blue continuing along its lateral line, while its muscular tracts are lighter and show a distinct purplish tinge.

Of all the Brotulidae the members of the genus *Lamprogrammus* are among the most interesting as examples of brotulid specialization. Their eyes are in the act of becoming lost behind very large mucous canals; their ventrals are quite gone, and they have developed a most intricate and conspicuous lateral line system, beautifully described by Garman, and well shown by these two specimens.

Mixonus caudalis Garman.

Mem. of the Mus. of Comp. Zoology XXIV, 1899, p. 148, Pl. XXXVI, fig. 2.

Station 74 in OT₃ from 833 fathoms one specimen (Field no. 5978) A.M.N.H. 7504.



Fig. 30. *Mixonus caudalis* Garman. Station 74 in OT₃ from 833 fathoms, one specimen (A.M.N.H. 7504).

This specimen measures in length from snout to base of caudal, 394 mm.; width across pectoral fin bases, 30 mm.; depth between pectoral fin bases, 49 mm.; length of the surface membrane of its eye, 11 mm. Its total body weight when fresh was 191 g.

It agrees with Garman's description save in the following particulars: it has 105 dorsal rays as opposed to Garman: D 97-103. It has four rudimentary gill-

rakers and one long one on the upper part of the first branchiostegal arch as opposed to Garman: three rudimentary gill-rakers and two long ones. Its caudal fin is only $\frac{1}{2}$ in head as opposed to Garman: caudal $\frac{3}{4}$ in head.

These differences may be accounted for by the fact that this specimen is four inches longer than the one upon which Garman bases his type description.

Color notes made immediately upon this specimen's being taken from the net add to Garman's very brief color description. They are as follows: body pale shading into light rosaline purple behind the vent. Belly blackish, shading into light neropalin blue under the pectorals. Operculum dusky blue. Head pale (skin torn, however, and muciparous ridges and cavities prominently exposed). Branchiostegals blackish, linings of mouth and branchial cavities forget-me-not blue. Posterior part of the dorsal and anal fins tipped with neropalin blue. Caudal pale.

Porogadus breviceps Garman.

Mem. of the Mus. of Comp. Zoology XXIV, 1899, p. 155.

Station 74, in OT₄ from 625 fathoms, five specimens, of which only one was an adult with well developed eggs partly extruded from an opening behind the vent. This adult specimen, Field no. 6022 (A.M.N.H. 7505) measures in length from snout to the base of caudal, 340 mm., in width across the pectoral fin bases, 33.5 mm., and in the length of the surface membrane of its eye, 9 mm.; total body weight when fresh was 83.3 g.

The four immature specimens, A.M.N.H. 8456, agree with the adult in proportions as well as characters and differ only in that they are smaller, paler and more blue in color and with less distinct scales. They are all very nearly the same size, the largest measuring, in length from snout to base of caudal, 207 mm.

To Garman's brief color description we may add that they all possess what seems to be a fairly consistent brotulid characteristic, one that exists at all events among all of the adult specimens that were taken on the *Arcturus* except *Lamprogrammus*: inside of the mouth and branchial cavities forget-me-not blue; belly, branchiostegals and opercula dark indulin blue. In general body color these *Porogadus breviceps* are a light tan in color with a faint bluish tinge.

Dicrolene nigra Garman.

Mem. of the Mus. of Comp. Zoology XXIV, 1899, p. 150, Pl. XXXVIII, fig. 2.

At Station 74 in the dredge, D₃, from 844 fathoms, one specimen (Field no. 6122) A.M.N.H. 7506; in OT₃ from 833 fathoms, one specimen (Field no. 5977) A.M.N.H. 7507; and in OT₄ from 625 fathoms 31 specimens, A.M.N.H. 8458, 8459, 8460.

All of these 33 individuals, ranging in length from 481 mm. to 125 mm. agree well with Garman's description except in the matter of color. Garman's color-notes on *Dicrolene nigra* are as follows: "Coloration of large individuals black. (His described type is but 255 mm. in length.) On the younger ones the bases of the fins appear whitish and the muscular tracts brown." This fits none of our specimens with exactitude and takes no cognisance of the marked

color variation that occurs within the species, a variation not to be confused with the color differences between the young and adult fish.

Of the 33 *Arcturus* specimens only 6 are adult; and each of these merit an individual word so striking is the color difference among them. (Field no. 6122) A.M.N.H. 7506 is a specimen measuring in length from snout to base of caudal, 404 mm., in width across pectoral fin bases, 35 mm., in depth, 57 mm., and in the length of the surface membrane of its eye, 14 mm. Color: body and head a deep, dusky blue with a few scattered scales of a lighter blue. Paired fins black. Unpaired fins also black but streaked with forget-me-not blue. Branchiostegals and belly dark indulin blue. Inside of mouth light forget-me-not blue except the top of the vomer which is Chinese violet.

This specimen has no eggs. Stomach contained a large red shrimp, *Benthescynus*, a form inhabiting the abyssal depths but not the bottom.

(Field no. 5977) A.M.N.H. 7507 measures in length from snout to base of caudal, 414 mm. Its total weight when fresh was 301 g. Color: body and head reddish brown. Paired and unpaired fins black. Branchiostegals and belly dark indulin blue. Inside of mouth light forget-me-not blue except the top of the vomer which is Chinese violet. This specimen has no eggs. A peculiar growth, possibly parasitic, on its flank behind gill-opening.

(Field no. 6044) A.M.N.H. 7508 measures in length, 463 mm. Color: definitely brownish as in 5977 A.M.N.H. 7507. This specimen has the 7 filamentous rays in its pectorals that Garman mentions as being a rare feature of the species.

(Field no. 6018) A.M.N.H. 7509 measures in length, 457 mm. Color: definitely bluish, as in 6122. Has well developed eggs.

(Field no. 6019) A.M.N.H. 7510 measures in length, 495 mm. Its total weight when fresh was 1 lb. Color: definitely bluish as in 6122. Has well developed eggs. The ovaries are enclosed in a thick membranous sack that is continuous with a funnel connecting with an opening just behind the vent. They measure 50 mm. in length, 20 mm. in depth, and 30 mm. in breadth. Dorsally they appear as one organ but ventrally their surrounding membrane has folded in, partly dividing them into right and left. Approximately there are 1500 "stems" in each ovary and upon each of these "stems" approximately 100 eggs are clustered, making a total number of approximately three hundred thousand eggs to the fish. This specimen has the 7 filamentous rays in its pectorals, sharing this exceptional character with (Field No. 6044) A.M.N.H. 7508, a specimen brownish in general color and without eggs.

Unnumbered specimen, new skeletonized, that measured in length, 404 mm. Color: definitely bluish. Had well developed eggs.

It may be seen then that of these 6 adults all of the gravid females are bluish in color and of those without eggs 2 are brownish and one is bluish. And this difference in colors persists strongly now even though the specimens have been in preservative for more than a year.

Of the immature *Dicrolene nigra* there are 27 specimens, ranging from 279 mm. to 125 mm. in length; of these 7 specimens are peculiarly distinguished by being of a darker brown, their fins black, the bases of the fins, branchiostegals and belly dark indulin blue; and the linings of their mouths the characteristic lighter blue; while 16 young specimens are distinctly, though by varying degrees, lighter in general brown tone of their bodies. The remaining specimens which

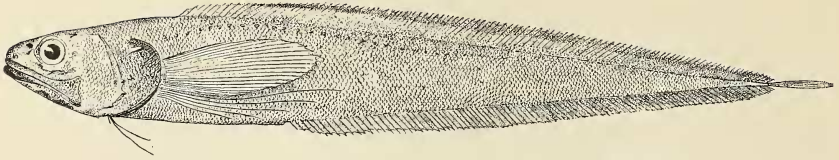


Fig. 31. *Dicrolene gregoryi* sp. nov. One specimen Station 74 in D₁ from 844 fathoms (A.M.N.H. 7511). From a pen drawing by Mrs. Louise Nash.

range from 153 mm. to 125 mm. in length are light enough to agree with Garman's description of the young color of the species, and the bases of their fins are definitely whitish. The color of these 4 small individuals is without question due to their youth.

As an example of the method of growth in this species it may perhaps be interesting to note that in a specimen 153 mm. in length, the body depth is 8 in its own length; while in a specimen 190 m. in length, the depth of body is 6.3 in its own length. Thus the young fish attains its girth less speedily than its length.

It may also be interesting to note that *Dicrolene intronigra*, the principal species of the Atlantic *Dicrolene* as *nigra* seems to be of the Pacific, comes to maturity at a much smaller size, for a specimen in the American Museum of Natural History (A.M.N.H. 3159) with well developed eggs, measures but 217 mm. in length.

Dicrolene gregoryi sp. nov.

Type. At Station 74, in D₁ from 844 fathoms one specimen. (Field no. 6063) A.M.N.H. 7511.

Length from snout to base of caudal, 237 mm.; depth in length, 7.4; longest ray of upper portion of pectoral, 5 mm.; longest ray of lower filamentous portion of pectoral, 4.5; body cavity, 2.7; head, 5. Snout in head, 4; eye 4.7; mouth, from anterior edge of premaxillary to posterior edge of maxillary, 1.5; longest dorsal ray, 3; anal ray 5.5; longest (the inner) ventral ray, 2.5; caudal, 2.5 Branchiostegals 8, Dorsal 111-114, Anal 96-99, Ventral 2 (plus a tiny serrate stump), Pectoral 20 + 5, Caudal 6 or 7.

Body compressed, elongate, tapering gradually to a narrow caudal; base of caudal 2 mm. across. Snout rather blunt, slightly longer than eye, not projecting at all beyond the point of the lower jaw which is shaped to fit into the toothless gap where the premaxillaries meet at the tip of the snout. Mouth large. The maxillary extending behind the orbit to a distance equal to $\frac{1}{2}$ of the orbit; and broadening so that its posterior edge is equal to the orbit; this broad flange of the maxillary is scaled. Teeth small, in villiform bands on the jaws and palatines, a small triangular patch on the anterior tip of the vomer and a narrow band down the middle of the "tongue" flanked a little posteriorly by two smaller bands. Eye fairly large, equal to interorbital space. Gills 4, a slit behind the fourth; rakers stout, the longest 1.6 in the eye; 4 on the upper and 12 on the lower branch of the first arch. Membranes not united, free from the isthmus. Operculum with a stout horizontal spine at its upper flap and a short spine projecting downward along its anterior surface. Three preopercular

spines and a sharp spine above the hinder border of each eye. Dorsal rays longer than anal; and the bases of these fins extend all the way to the origin of the caudal. The caudal consists of 6 or 7 rather long slender rays. The ventrals have their origin just behind the humeral symphysis; they each consist of two delicate rays that are bound together for a short distance at the base, and on the outer side of each of these and close to their base is a small serrate stump no longer than the extent to which the bifid ventral rays are bound together. The upper pectoral rays are united, the lower rays separate, long and stronger than the rays of the upper pectoral.

The lateral line is fairly prominent anteriorly, rising rather abruptly towards the dorsal fin until under about the 13th ray where it is but 4 mm. distant from the base of the dorsal; it continues along the base of the dorsal until about the 72nd ray when it disappears. Air bladder large, thick walled and white as is characteristic of many genera of Brotulidae, if not of all.

Color in alcohol; muscular tracts pale tan; dorsal fin pale along its base which is heavily and finely scaled, but tipped with dusky brown. Anal unscaled, dusky brown all over. Caudal and pectoral dark brown. Belly bluish. Opercula, branchiostegals, head and inside of mouth dark brown.

This species is closer to *Dicrolene nigra* than to any other of the known species of *Dicrolene*. It is to be distinguished from *Dicrolene nigra* principally by the color, the size of the eye, and most significantly by the size and number of the scales.

On an oblique line from the origin of the anal fin to the origin of the dorsal—and a single line may be followed directly between these two points—there are 65 rows of scales whereas a similar count of scales on *Dicrolene nigra* shows 80 rows. Similarly from the nape to the origin of the dorsal there are 18 rows of scales, while in *Dicrolene nigra* there are 22 rows.

This type specimen had in its stomach a small white shrimp, *Euphausia*, a form living, as a rule, above 500 fathoms.

Species named for Doctor William K. Gregory, Associate in Vertebrates on the Arcturus Oceanographic Expedition.

Monomitopus torvus Garman.

Mem. of the Mus. of Comp. Zoology XXIV, p. 157, Pl. XL, fig. 1.

At Station 74 in OT₄ from 625 fathoms, 35 specimens (A.M.N.H. 8642), of which 4, 7503, 8461, were so much bluer in color that at first sight they were thought to be of a different species and were given the temporary name of "Blue Brotulid" to distinguish them from the other larger specimens which were called the "Brown Brotulids." Upon examination it was readily seen, however, that these "Blue Brotulids" were of the same species.

They all agree well with Garman's description, with the possible difference that many of them have but 29 and 30 rays in their pectoral fins instead of: pectoral 32-33; and except for a decided color variation within the species. For beside the difference in color displayed by the four small "Blue Brotulids," that average 140 mm. in length, there is a distinct variation among the adult fishes.

The color of the species as a whole is as follows: body brown, fins a darker

brown; forget-me-not blue scales scattered over the unshaded brown of the muscular tracts and concentrated at the bases of the unpaired fins and of the pectorals making the color in those spots pronouncedly blue. The color of the four young fish, the largest of which measures in length 145 mm., differs from this description only in that the muscular tracts are of a paler tan overlaid with a powdery blue tinge.

But among the adult fishes that range in length from 406 mm. to 210 mm. there is a color difference not to be explained by immaturity. For of 31 adult individuals, 15 are of a much darker brown and have more conspicuous blue scales overlying the brown. All of these 15 individuals have eggs in various stages of development, while of the 16 specimens that do not have eggs, 4 are dark and covered with scales of a deeper blue, indistinguishable in color from the gravid females; and 12 specimens, though by varying degrees, are light and the bases of their fins are tinged with a paler blue.

Some of the individuals without eggs are smaller than any of the gravid females, it is true, for the smallest specimen carrying eggs is 220 mm. in length, and there are four specimens without eggs that are smaller than this. But of these four specimens 2 share the dark color of the mature females while the other two are conspicuously lighter.

As an example of the method of growth in this species it may be noted that in a specimen 310 mm. in length, the body depth is 5.6 in its own length; while in a specimen 145 mm. in length, the depth is 6.5, showing the same ratio of proportion in their growth as *Dicrolene nigra*.

The ovaries (of 6005, A.M.N.H. 7502), a specimen measuring 310 mm. in length, are apparently identical in form and structure to the ovaries of *Dicrolene nigra* (A.M.N.H. 7510). They measure 27 mm. in length; 9.5 in depth; 13.5 in breadth. There are approximately 60 "stems" in each ovary and the eggs clustering upon these stems seem very much smaller and more numerous than the eggs of *Dicrolene nigra*.

At Station 84, Lat. 0° 17' S., Long. 91° 34' W., one mile north of Narborough Island of the Galapagos, in T₂ from a depth of 400 fathoms three specimens (Field no. 6386) A.M.N.H. 8454.

Although these specimens are small, the largest of them measuring from snout to the base of caudal, 33 mm., in width across the pectoral fin bases, 4.8, in depth between the pectoral fin bases, 7 mm. and in the diameter of eye, 1.5, they, nevertheless, agree so well with Garman's description of the adult *Monomitopus torvus* that there is not much question of their belonging to that species. In general appearance and in all proportions and especially in the position and character of their ventrals, they agree perfectly, only differing as to fin count. Dorsal 96-101 as opposed to Garman: Dorsal 107-111; Anal 69-80 as opposed to Garman: Anal 86-95; and Caudal 12-13 as opposed to Garman: Caudal 8. As the caudal fins of these young specimens are not very clearly differentiated, however, this may account for the difference, for some of their rays that now seem to pertain to the caudal may later belong to the dorsal and anal fins respectively. They agree in the number of their pectoral rays as well as of their ventral.

While in the adult of the species the muciparous pores are rather vaguely indicated as holes or cavities under the skin, in these three young specimens

they are very clearly defined as holes in the loose skin of the head. They are arranged as follows: three anterior to the origin of the maxilla, the first in front of and under the anterior nostril, the second close beside the first, still under the anterior nostril but more on the slope of the premaxilla, while the third is slightly in front of and below the posterior nostril. The fourth little hole is below the anterior border of the orbit. And on the lower jaw there are four open pores, the first placed beneath the second one of the series on the upper jaw, and the other three occurring in equidistant succession, the last of the four being situated well behind the posterior edge of the maxilla.

The anterior nostril of these young specimens is distinctly tubular in form, whereas the anterior nostril of *Monomitopus trovus*, the adult, is described as being upon a tumid prominence. But young and adult agree in having the anterior part of their lateral lines emphasized and in the suggestion of threefoldness of these lateral lines.

In color these three specimens are of a rather dark brown, agreeing better with the adult specimens than with the immature specimens (those averaging 140 mm. in length), and they show no indication of any blueness. And the inside of their mouth and branchial chambers is white instead of the forget-me-not blue characteristic of the specimens from Station 74. Two of them, however, display vague, broad bars of a slightly darker brown running, vertically, about three of them in the body tract. While the third specimen exhibits no such ornamentation.

At Station 87, Lat. 0° 00', Long. 91° 53' W. in T₃, from a depth of 450 fathoms, one specimen, measuring 33 mm. and agreeing in every particular with the three young individuals from Station 84. In color this specimen agrees with the one from Station 84 that gives no indication of darker cross bars on the brown of its muscular tract.

***Cherublemma* gen. nov.**

Body and head compressed. Clavicular bones produced, meeting under the eye. Ventral fins close together on the humeral symphysis, originating on a vertical, slightly anterior to the posterior edge of the orbit, and consisting of 2 pairs of bifid rays. Pectorals broad, simple. Vertical fins united. Large, flat opercular spine, no preopercular spines. Gill membranes not united, free from the isthmus. Eye lateral, fairly large. Snout moderate, blunt. Nostrils rather large and close together in the centre of the side of the snout. Mouth wide, oblique.

***Cherublemma*⁹ *lelepris*¹⁰ sp. nov.**

Type. At Station 26, Lat. 5° 03' N., Long. 81° 08' W. in T₄ from a depth of 140 fathoms, one specimen (Field no. 5108) A.M.N.H. 8463.

Length from snout to base of caudal, 33 mm. Depth between pectoral fin bases, in length, 4.7; width, between pectoral fin bases, in length, 11.5; body cavity, from tip of snout to vent, in length, 2.5; head, in length, 5.5. Head, from tip of snout to posterior border of operculum, 6.5. Snout in head, 4.5;

⁹ Lemma = a subject for discussion or doubt.

¹⁰ Lelepris = an unknown fish mentioned in Pliny.



Fig. 32. *Cherublemma lelepris* gen. et sp. nov.
From a drawing in colors by Isabel Cooper.

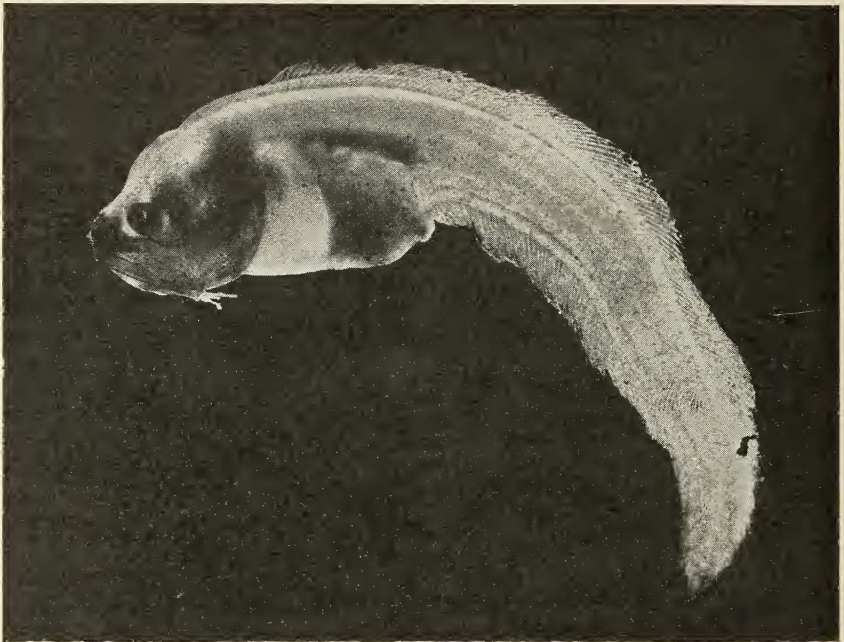


Fig. 33. *Cherublemma lelepris* gen. et sp. nov. Station 26 in T₄ from a depth of 140 fathoms (A.M.N.H. 8463). From a photograph of the type specimen.

eye, 5; mouth, from anterior edge of premaxillary to posterior edge of maxillary, 5; longest dorsal ray, 1.5; anal ray, 3.5; pectoral ray, 2.5; ventral ray, 2; caudal, 3.5.

Brr.? D 118-120 A 85-87 P 24-25 V 2 bifid rays C 8-9.

Body compressed, elongate, tapering gradually to a narrow caudal. Snout blunt, not projecting at all beyond lower jaw. Profile like a pug-dog's, forehead above anterior edge of orbit rising abruptly and then continuing in a gradual slope to the origin of the dorsal fin. Mouth large, terminating, on a vertical, behind the orbit, by a space equal to $\frac{3}{4}$ of the diameter of the orbit. Teeth small, conical, irregularly and rather widely placed along the edge of the premaxillary. Eye fairly large, equal to the interorbital space. Nostrils conspicuous, placed nearer to each other than the anterior nostril is near to the eye, or the posterior to the snout. Gill membranes not united, free from isthmus. Operculum with a broad flat spine at its upper edge. Origin of dorsal above the base of the pectoral; of the anal at a distance 1.1 in head behind the base of the pectoral. Dorsal rays longer than those of anal, the bases of both fins extending to caudal, which is not very conspicuously differentiated and consists of 8 or 9 rather short rays. The ventrals arise from the humeral symphysis on a vertical from the anterior edge of the pupil of the eye; their bases close together. Each ventral fin consists of two rather stout rays that become freely bifid at a distance of about 2 mm. from their base. The pectoral rays are simple and the fin broad and rounded in outline. Of any lateral line there is only a faint trace on the "shoulder" above and behind the top of the operculum.

Color in alcohol: body and head cream colored with scattering of dark pigment "stars" more frequent on the head which still retains too a yellow tinge about the operculi. Fins white, except for the tips of the vertical fins which are dusky. Eye: iris dark blue.

Color in life: Body faintly tinged with lemon chrome that becomes stronger on the head and anterior body. On the head, snout, nape and opercula, a definite pigmentation, a sprinkling of pomegranite purple. Eye: iris pale green. Base of unpaired fins white, their tips dusky. Pectorals and ventrals white.¹¹

This genus *Cherublema* may be fitted into Smith and Radcliffe's key,¹² the most recent arrangement of the genera of the brotulids, as follows:

a' Sirembinae

Clavicular bone greatly produced, meeting below eye; ventral fins inserted under eyes, behind tip of humeral symphysis.

b' Preopercle unarmed; snout without sharp spine at tip; head entirely scaled; ventral simple. *Siremba*.

b'' Ventrals consisting of 2 pairs of bifid rays. **Cherublema**.

b² Preopercle with 3 spines; snout with a sharp spine—head practically naked, ventrals bifid. *Hoplobrotula*.

¹¹ During the process of examination one of the ventral fins of this specimen A.M.N.H. 8463 was torn off, most unfortunately. The remaining ventral is in good condition, however, and clearly shows the two bifid rays. While it was still intact this fish had a most conspicuous pair of ventrals, rays below its chin, 8.

¹² "Description of Fishes of the Families Brotulidae, etc. . . . from the Philippine Islands and the Dutch East Indies. 'Albatross' 1907-1910." By H. M. Smith & Lewis Radcliff. Proc. U. S. Nat. Mus., vol. 44.

a² Neobythitinae.

Position of humeral symphysis normal behind eyes, etc.

Cherublemma lelepris then, is closest to the genus *Siremo* "Bleeker, 22;¹³ orthotype *Brotula imberbis*—T. & S. There is a good description of this genus as represented by *Brotula imberbis* (now *Siremo imberbis*) in Fauna Japonica.¹⁴ Our fish differs from this description in: the character of the ventrals, of the mouth and teeth and the size of the eye; in fin counts and color. It, however, agrees better with it—and not only on account of the position of the ventrals—than with any of the Neobythitinae in which sub-family most of the known genera and all of the other genera of brotulids taken on the *Arcturus* belong.

Imberbis is the only species known of this genus *Siremo* as limited by Gill, for "Vaillant's *Siremo* is a congeries of heterogeneous forms, including, probably, the representations of three subfamilies."¹⁵

And on account of this paucity of representation and because this specimen (Field no. 5108, A.M.N.H. 8463) is, by no means, an adult individual, I have been very loth to believe that it did represent a new genus. And were it not so widely different—and yet not with differences that seem of purely larval extravagance—I should not have ventured to consider it with seriousness. But, although I have been able to find nothing in the literature concerning larval or young brotulids, I think I have perceived, through studying five specimens of brotulids, 33 mm. and smaller, that were taken on the 'Arcturus,' enough characters typically brotuloid that persist with stability in these young stages upon which to base my notion that *Cherublemma lelepris* by departing from them marks itself as unique.

Of these young *Arcturus* brotulids one in particular (Field no. 630 A.M.N.H. 8464) from Station 86, in T₄ from a depth of 800 fathoms, a specimen measuring 22.2 mm. in length, gives rather significant indications of these characters that I believe may be considered stable. In proportions, fin counts and other characters this specimen foreshadows any of six or seven genera of the sub-family Neobythitinae, and therefore it has been impossible to determine it; but it is unmistakably brotuloid and has most of the conventional characters of the Neobythitinae in perfect miniature, including general proportions, a sharp opercular spine, large nostrils, the anterior one close to the tip of snout, the posterior to the orbit; ventrals consisting of a pair of simple filaments close together behind the humeral symphysis and slightly forward of the base of the pectorals. It seems significant, too, that the four other specimens, 33 mm. and under should possess the characteristic ventrals, opercular spines and general body shape.

I have been careful, however, to impute to *Cherublemma* no characters, that, from what I learn from these young individuals, may not have generic value, such as the color, the abruptly rising forehead and in particular the teeth. That these teeth,—small, conical, and rather widely and irregularly placed along the premaxillary,—are on the way to becoming villiform seems not improbable,

¹³ Bleeker 1858. cr. "The Genera of Fishes," by David Starr Jordan. Leland Stanford Junior Univ. Pub. Univ. Series, 1919. Part II.

¹⁴ "Fauna Japonica," by Temminck & Schlegel. 1850, p. 253, pl. CXI, fig. 3.

¹⁵ "Oceanic Ichthyology," by Goode and Bean. P. 340.

especially since the teeth of the tiny brotulid, A.M.N.H. 8464, (22.2 mm. in length) resemble them.

SUMMARY

We have seen that within the species *Dicrolene nigra*, of 6 adults, all of the gravid females are, in general, dark blue, and of the individuals without eggs one is dark blue and the other two are brown. And of 23 immature but fairly large specimens, 7 are conspicuously dark and the other 16 are lighter, though by varying degrees, as though they presaged the adult color differences.

Within the species *Monomitopus torvus*, among 31 adults, all of the 15 gravid females are a dark brown and their scales—those few not torn off in the nets—of a deep blue; and of the 16 adults without eggs, 4 are dark and 12 are, though by varying degrees, lighter, while their scales except those about the bases of the fins are not blue.

In *Porogadus breviceps* there are none but immature specimens with which to compare the one gravid female.

In *Lamprogrammus illustris*, the gravid female is distinctly blue while the specimen without eggs is brown. This individual, however, is perhaps too immature for its color to be of significance.

From this evidence, however, it seems true that there is a sexual color difference among at least two species of two genera of Brotulidae.

But why such a variation should occur among fish that live below the 600 fathom line, and usually deeper, is a problem apt to remain in as profound an obscurity as the depths themselves. For it seems reasonable to suppose that if these fish exhibited any sexual difference as an aid to recognition and courtship it would appear in the arrangement of the muciparus channels of the head and lateral line that are believed to be luminous, rather than by means of a coloration that must, one thinks, be indistinguishable to brotulid, if not to any eyes at that depth. A guess may be, perhaps, hazarded that color distinguishes the sexes of these bathybial species only as the expression of a recollection of an ancient littoral existence where courtship-colors were the rule. For these brotulids are inhabitants of the shallower abyssal depths where the obscurity may have acted as yet "only in relation to the sensibility of their retina, but not that of their skin."¹⁶

¹⁶ "Observations anatomiques et biologiques sur quelques poissons des très grandes profondeurs marines," by Louis Roule. C. R. Mém. Soc. Biol. Paris, 1916, vol. 79.

Nor is it at present possible to tell from what littoral forms—"degraded blennies" or any other—the brotulids are descended, for all of the marine brotulids are, at this stage in their history, abyssal and have no relatives that live where they can be observed, with the exception of some fresh-water cave-dwelling brotulids that have transparent skins without pigmentation, and eyes dwindling and even sunk under the skin of their heads. There are two species of very deep-dwelling marine brotulids that parallel the degeneration of these cave species. And, indeed, the brotulids are the Deep Sea Fishes par excellence, perfect examples of: "Those out-of-date forms of life which can no longer compete with the vigorous shore-dwelling races, and are compelled to retreat to the fresh waters on the one hand, or to the deep sea on the other."¹⁷

Nor are there any fossil records of these refugees from the stress of shallow waters. If the family Brotulidae is of the Order Anacanthini it is of an Order that is entirely absent from the whole Cretaceous period.

If anything were known about the method of reproduction in the family Brotulidae some light might be shed upon the causes of this color variation that exists among some of them, slight though it may be. But although some brotulids are known to be viviparous and more are known to be oviparous, that is all.

Are their eggs pelagic or demersal? It may be pertinent here to say that Gilchrist¹⁸ believes that the eggs of several genera of macrurids are pelagic and rise to the top of the water after they are laid, unless, indeed, he says, the pressure and the salinity in opposition to one another hold the eggs motionless in a mid-vertical area!

Is there a breeding season among the brotulids and with it a vertical migration? Certainly the largest haul of brotulids on the *Arcturus*, most of the fish being gravid females, came from the "shallower depths" of Station 74, 625 fathoms; while in the dredges from 844 to 833 fathoms there were but two brotulids—one in each dredge—and neither of these carried eggs.

It is generally, if vaguely, supposed that young brotulids live nearer to the surface than do the adults, and all of the young brotulids of the *Arcturus* were taken comparatively near the surface.

¹⁷ "The Antiquity of Deep Sea Fish Fauna," by A. Smith Woodward. *Natural Science*, 1898, vol. 12.

¹⁸ "The Reproduction of Deep Sea Fishes," by J. D. F. Gilchrist. *Annals & Magazine of Natural History*, 1921, 9th ser., vol. 7, p. 173.

This may imply that brotulid eggs are somewhat if not entirely pelagic, and if such is the case, it is not extravagant to suppose that the adults themselves migrate upward to lay their eggs above the depths where pressure might prevent the free eggs from rising. For, if their recollection of a littoral existence is still strong enough to cause a variation of color between the sexes, it might also be strong enough to remind them of the seasons that once influenced their habits.

Finally, out of a family numbering 44 genera and more than 100 species, is anything of their life history known save the meagre facts here recorded? It is to be hoped, and is the purpose of this paper, that these *Arcturus* brotulids may arouse the interest of specialists who will discover and elucidate more facts concerning the life history and phylogenetic relationships of this interesting family.